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Title: FIND GAS SOURCE (FIGS) NEURAL NETWORK SOFTWARE

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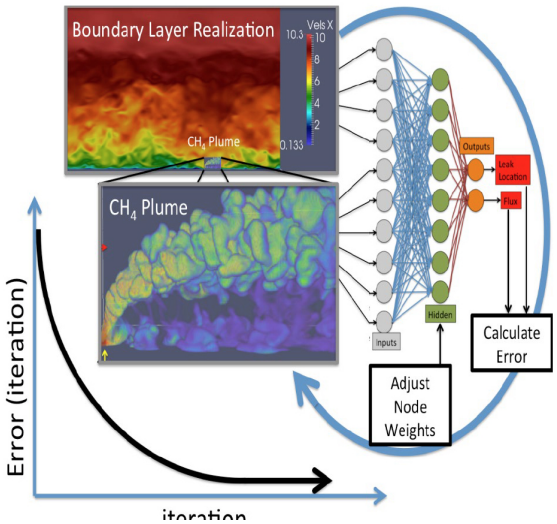

Los Alamos NATIONAL LABORATORY EST.1943

Tech Snapshot

Earth and Environmental

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FIND GAS SOURCE (FIGS) NEURAL NETWORK SOFTWARE

R&D 100 Winner - 2019

SUMMARY

Researchers at Los Alamos National Laboratory have developed Find Gas Source software (FIGS), an artificial neural network tool that integrates data from methane and ethane sensors with wind fields from sonic anemometers to accurately locate and quantify natural gas leaks from oil and gas upstream, midstream, and downstream infrastructure. The system has been successfully tested on both stationary and mobile platforms in blind tests. The FIGS neural network improves the cost-effectiveness, safety, and reduces the time for leak detection of current atmospheric sensor technologies. FIGS is an essential component of the ALFa-LDS low-cost, fast leak detection system, which won a R&D 100 Award.

MARKET

The natural gas pipeline network in the United States alone encompasses hundreds of processing facilities, hundreds of thousands of wells, and over 3 million miles of mainline and other pipelines that link natural gas production areas and storage facilities with consumers (U.S. Energy Information Administration). The natural gas leak detection and repair market represents an under-served sector with significant opportunity for growth in coming years. In order to make natural gas safe and 'greener' than coal combustion, methane leaks must be minimized. Recently-passed state initiatives (e.g. California, Colorado and New Mexico) and potentially Federal legislation will drive the market for accurate and cost-effective methane leak detection. FIGS-based systems may also be applied to industrial gas leak detection for toxic species such as H2S, CO, and formaldehyde.

BENEFITS

FIGS coupled with sensitive gas sensors and a 3-D anemometer allows and automates precise location and quantification of methane and other gas leaks at a pad-scale or other local infrastructure scale with a minimum of hands-on personnel intervention and at low cost.

- FIGS plus point methane sensors on a well pad can be more cost effective than competing methods
- FIGS plus point methane sensors can operate autonomously providing essentially real-time detection capability
- FIGS plus point methane sensors can provide leak mapping and location visualization
- FIGS plus point methane sensors distinguishes natural gas leaks from biogenic sources
- FIGS can be configured to work with a range of gas sensors (methane, ethane, other hydrocarbons, hydrogen sulfide, formaldehyde...
- FIGS enables a safer method for leak detection than manual surveys, which are potentially hazardous when completed in natural gas leak situations

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WHY WE ARE BUILDING FIND GAS SOURCE (FIGS) NEURAL NETWORK SOFTWARE

Natural gas, composed of methane and other light hydrocarbons, is a relatively clean-burning fossil fuel, which produces significantly less CO2 when combusted than coal. However, methane is an explosive hazard and a potent greenhouse gas. Methane leaks undercut the climate benefits of natural gas combustion (relative to coal). Thus, methane leaks must be minimized across upstream and midstream infrastructure; FIGS represent a potentially important component to detect such leaks in an autonomous, cost-effective fashion.

WHAT'S BEHIND OUR TECHNOLOGY

FIGS maximizes methane detection accuracy and speed and minimizes false positives by training a neural network using high-resolution plume dispersion simulations over a range of hypothetical leak scenarios and meteorological conditions. The neural network code is a matrix of weights applied to a vector of input values (wind fields and methane/ethane signals) to produce a vector of output values (leak location and strength). A translation function is determined by adjusting hidden variables to achieve the best correlation between the input and output. The field-deployed neural network is then able to provide automated detection and classification capability in near-real time with minimal computing resources and little human intervention. The FIGS-based system has outperformed a range of other methane-detection systems in government-sponsored tests.

OUR COMPETITIVE ADVANTAGES

FIGS coupled with point-source gas detectors and sonic anemometers detects very small natural gas leaks with minimal false positives, provides leak location diagnostics via artificial intelligence methods, supports autonomous operations under rugged conditions, and has low power requirements - all at a competitive price compared to other methane sensing technologies. This can be accomplished with such minimal computing requirements that the algorithm can be run on a very small Beagle Bone computer, which is low power, and the size of a credit card—yet is capable of delivering data processing and analysis in real time. Most competing methane sensing technologies are lacking one or more of the qualities that characterize FIGS-based sensor systems.

OUR TECHNOLOGY STATUS

FIGS-based systems have been developed at the bench-scale and have been tested during field-scale tests in both a stationary mode at the Colorado METEC facility and on vehicles at Stanford's Natural Gas Initiative facility; UAV test are in the preliminary stage. Next steps would require an industrial partner to develop a robust commercial version of the software and further field-test integrated systems. This could be achieved through exclusive/non-exclusive copyright licensing coupled with a CRADA.

PUBLICATIONS AND IP

Publications

Travis, B.J., Dubey, M.K., Sauer, J.A. (in prep) "Autonomous, Low-cost, Fast Leak Detection System that Harnesses Neural Networks to Locate and Quantify Fugitive Natural Gas Leaks" *Atmospheric Measurement Techniques*. LAUR-19-22721.

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